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(54) Abstract Title

**Process for the heat-soak treatment of tempered glass panels**

(57) A process for the heat-soak treatment of tempered glass panels comprises heating the tempered glass (or cooling of the glass is stopped) to maintain the temperature for the duration of e.g. a good minute within the range of 340-370°C, by means of hot air blasting such that glasses, which would break spontaneously in time as a result of NiS-stones, shatter immediately. During the heating sequence or the cooling stop sequence and during the subsequent cooling sequence, the glass panel is carried in a horizontal plane, e.g. back and forth on rollers in an oscillating fashion. The process is a continuous-action process and apparatus for carrying out the process can be hooked up with a tempering machine for an on-line operation.

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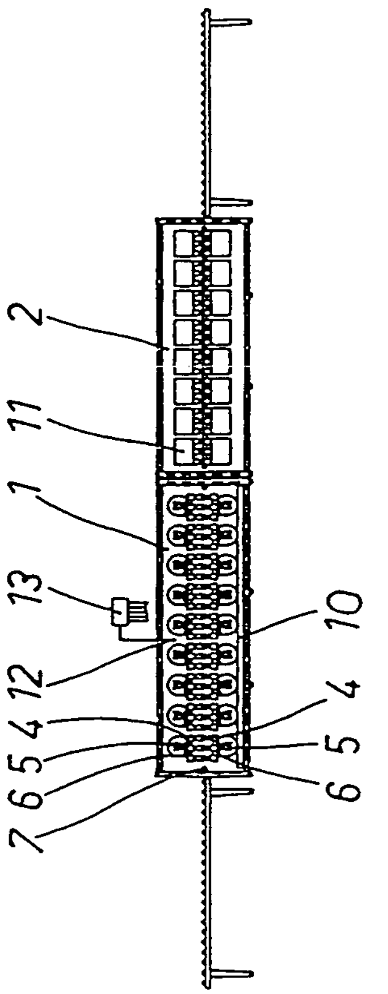


Fig. 1

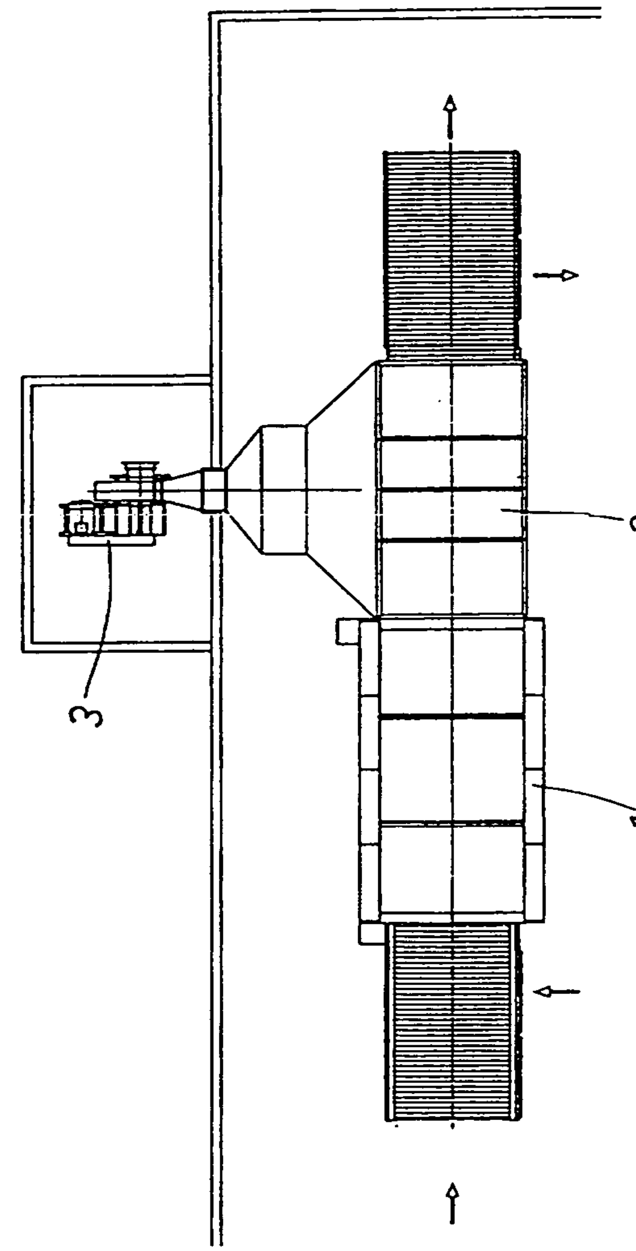


Fig. 3

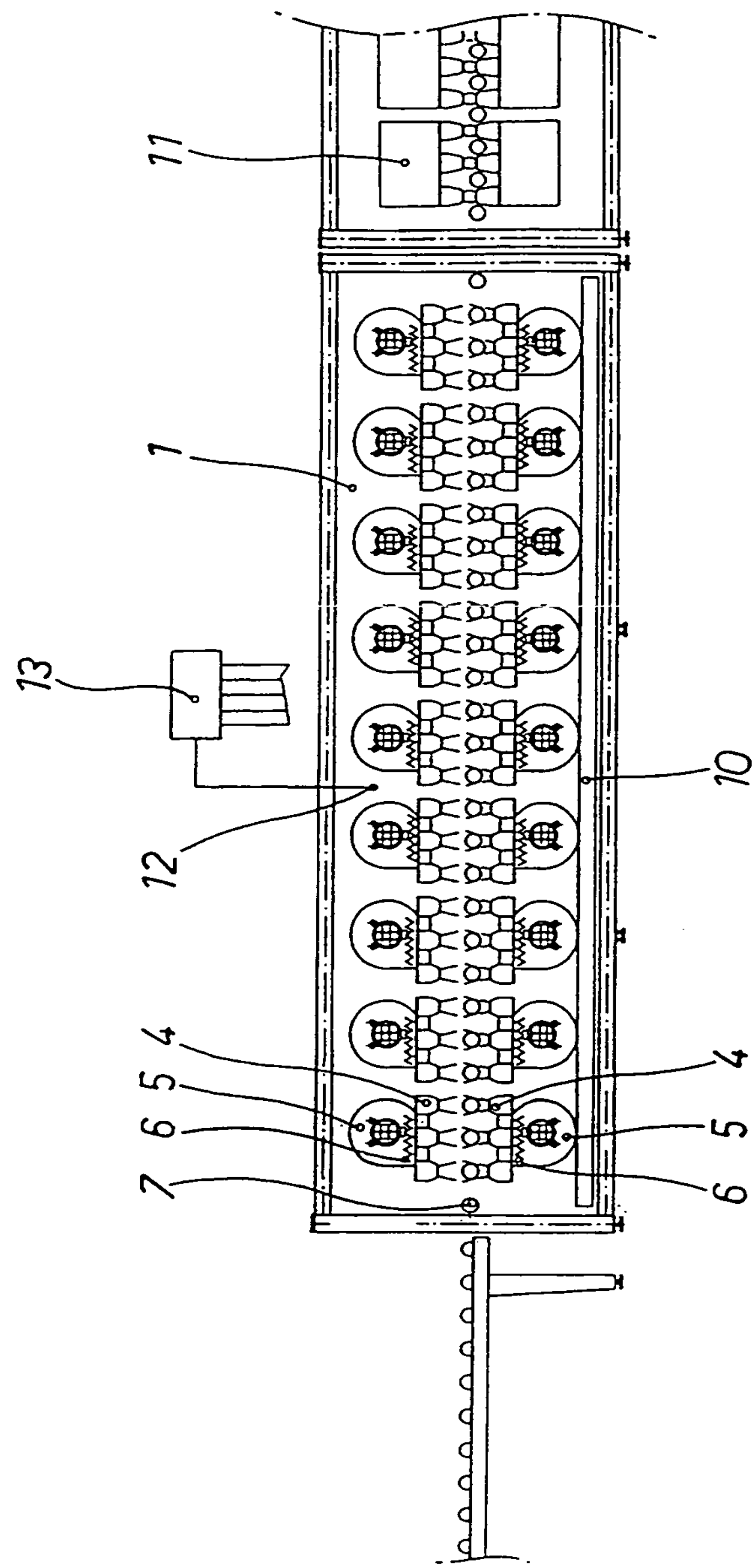


Fig.1A

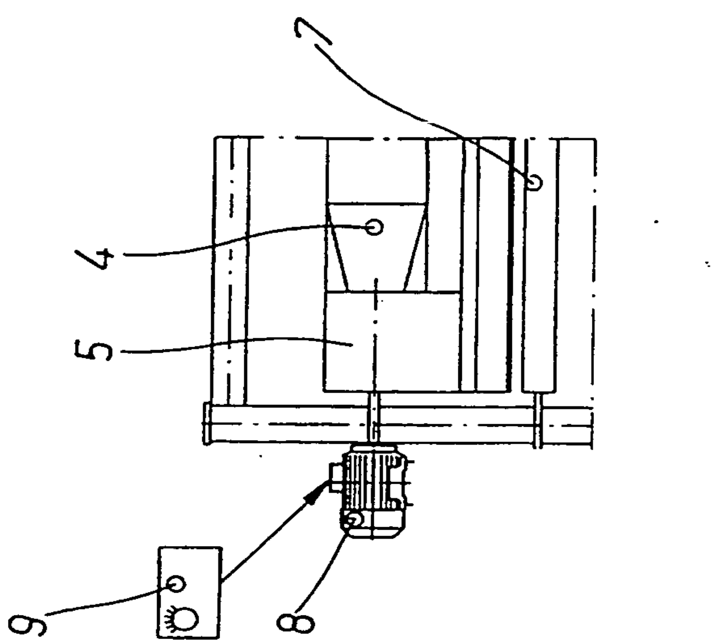


Fig. 2

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# Process for heat-soak treatment of tempered glass panels

The present invention relates to a process for the heat-soak treatment of tempered glass panels, in which process the glass panel is allowed to cool from the tempering temperature to a temperature below 379°C, most preferably to about 300°C, whereafter the glass panel is heated to the range of 350-360°C and cooled again.

Alternatively, the invention relates to a process for the heat-soak treatment of tempered glass panels, in which process the cooling sequence of a cooling glass panel emerging from temper is temporarily stopped at a given temperature, as described hereinafter in more detail.

The so-called heat-soak process is based on the following known principles:

1. The NiS-stones appearing in glass at 379°C or higher are always in a stable alpha-form.

2. When glass cools to below 379°C, this stable alpha-form becomes unstable and begins to convert as a function of time and temperature all the way to a beta-form.

3. The conversion brings forth a stone volume growth of 2.38 %. This volume change results in a tensile stress around the stone.

4. If this tensile stress lies within the tensile stress range of tempered glass and the tensile stress developed around the stone surpasses the tensile strength of glass, the glass will explode into fragments.

5. It has been stated as a fundamental piece of information that the conversion from an alpha-form into a beta-form takes about 1 minute with glass having a temperature of

350°C and about 7 months with glass having a temperature of 80°C and 5,7 years with glass having a temperature of 30°C.

The thermal treatment known as a heat-soak process is used for prebreaking those glasses which, for the above reason, would spontaneously break in use within a few years.

The currently known heat-soak processes are batch type processes. A rather large number of tempered glasses (e.g. 3000 kg) are held in a heating chamber at a temperature of e.g. 280-300°C for several hours, e.g. 8 hours. This prior known process is slow and requires laborious handling of batch loads.

The published application WO 9601792 discloses a process, wherein the heat-soak thermal treatment is carried out at a temperature of above 300°C for at least two hours, followed by another tempering process for eliminating a drop in the degree of temper caused by the heat-soak process. A draw-back also in this method is a relatively long heat-soak process and also a necessary second tempering process.

An object of the invention is to provide a novel type of heat-soak process, which is expedient and, if desired, can be hooked in on-line operation with a tempering machine.

This object is achieved by means of the invention on the basis of the characterizing features set forth in the appended claim 1 or alternatively in claim 2.

The invention is based on the discovery that, at a relatively high temperature (340-370°C), the time needed for a reasonably effective heat-soak process is sufficiently short (from one minute to a few minutes, depending on glass thickness), such that there is no time for the degree of temper to fall significantly.

The non-independent claims disclose preferred embodiments

of the invention.
In order that the invention may be illustrated, more readily appreciated and carried into effect by those skilled in the art, embodiments thereof will now be described in more detail by way of non-limiting example only with reference to the accompanying drawings, in which

fig. 1 shows an apparatus for implementing a process of the invention, in a schematic vertical section;

fig. 1A shows a portion of fig. 1 in a larger scale;

fig. 2 shows schematically a detail in a heating section included in the apparatus and

fig. 3 shows an apparatus for implementing the process, in a schematic plan view.

The apparatus for implementing the process includes a furnace 1 operating on convection principle and a cooling section 2, into which a blower 3 supplies cooling air.

Above and below a conveyor constituted by rollers 7, the heating furnace 1 includes nozzle boxes 4 provided with blowers 5 for circulating hot air between the furnace interior and nozzles or orifices existing near the surface of a glass panel. The nozzle boxes 4 are provided with heating resistances 6 between the blower 5 and the nozzle orifices. A temperature sensor 12 measuring the temperature of the air in the furnace 1 regulates the effect supplied to the resistances 6, such that the furnace air maintains its temperature at a desired set value. This temperature is typically about 300-400°C and the tempered glass arriving in the furnace has a temperature which is substantially below 379°C. According to a first alternative of the invention, the glass arriving in the heat-soak furnace 1 has a temperature of about 300°C, the glass panel heating in the furnace to about 350-360°C. According to a second alternative of the invention, the cooling of a glass emerging from temper is stopped e.g. for the duration of a good minute by

means of hot-air blasting in the furnace 1 for maintaining the glass at a temperature of 340-370°C, most preferably at a temperature of about 350-360°C. Thus, the air blasted by the blowers 5 is heated to a matching temperature.

The heating effect can be controlled not only by regulating the output of the heating resistances 6 but also by regulating the rotating speed of the blowers 5, the coefficient of heat transfer of convection blasting changing accordingly. The regulation can be implemented in such a way that the inverter drive of blower motors 8 controls automatically the rotating speed of the blowers. A regulator 9 can be used e.g. for setting the rotating speeds adjusted for various glass thicknesses. If desired, the regulation can also be implemented in such a way that the rotating speed rises automatically during a control sequence, as described in the Applicant's patent FI 86764.

After maintaining the glass at a temperature of 350-360°C for the duration of at least one minute (in case of thicker, 6-8 mm glasses, a few minutes), the glass is carried into a cooling section 2, wherein nozzle boxes 11 mounted above and below a roller conveyor are used for blasting cooling air to both surfaces of the glass.

In the furnace 1, the lower nozzle boxes are located directly below the rollers for leaving therebetween vertically clear gaps for dropping broken glasses therethrough onto a conveyor 10, which carries the glass fragments and crumbs out of the furnace 1.

Said conversion from alpha-form to beta-form occurs in the furnace 1 in a very high probability (in a probability of at least about 90 %). The glasses, in which this conversion has occurred, explode to fragments during a temperature equalizing period sustained in the furnace 1 as the temperature is within the range of 340-370°C, most preferably within the range of 350-360°C. In practice, the glass

panels can be cooled within the section 2 to a suitable handling temperature, e.g. below 100°C, prior to passing the same onto a discharge conveyor.

A process of the invention can be carried out with a separate machine or with a machine, constructed as a direct extension to a tempering machine and operating on the on-line principle, such that the glass panels progress through the heat-soak process essentially in the same time as through the tempering machine. This facilitates and expedites essentially the handling of tempered glasses.

In order to achieve a necessary treatment period in the section 1, the glass panels are manoeuvered within the sections 1 and 2 back and forth, i.e. in an oscillating motion. If the process period required in the heat-soak machines is substantially longer than that of the tempering machines (e.g. if a very high probability of conversion is desired), it is possible to construct two heat-soak machines in parallel as an extension to a single tempering machine, the continuous action being provided by diverging the glass panels emerging from the tempering machine alternately to different heat-soak machines. The same result can be achieved by charging and discharging a single longer heat-soak furnace multi-sequentially, whereby said furnace contains two or more not coincidental loads.

Claims

1. A process for the heat-soak treatment of tempered glass panels, in which process the glass panel is allowed to cool from the tempering temperature to a temperature below 379°C, most preferably to about 300°C, whereafter the glass panel is heated and cooled again, characterized in that, during the heating sequence, the glass panel is maintained at a temperature of 340–370°C, most preferably at a temperature of 350–360°C, and that, during said heating sequence and re-cooling sequence, the glass panel is advanced in a horizontal plane and the heating and/or cooling is carried out by using forced convection.

2. A process for the heat-soak treatment of tempered glass panels, characterized in that the cooling process of a cooling glass emerging from temper is stopped temporarily by means of hot-air blasting effected in a furnace for maintaining the glass at a temperature of 340–370°C, most preferably at a temperature of about 350-360°C.

3. A process as claimed in claim 2, characterized in that the duration of said cooling stop sequence is about one minute, no more than a few minutes.

4. A process as claimed in claim 1, characterized in that the heating is carried out with convection blowers, the air blasted thereby being heated to a temperature of above 380°C, most preferably to a temperature of about 400°C.

5. A process as claimed in claim 1 or 2, characterized in that the cooling stop is carried out with convection blowers, the air blasted thereby being heated to a temperature of 340–370°C, most preferably to a temperature of 350–360°C.

6. A process as claimed in claim 3 or 4, c h a r a c t e r i z e d in that the effect of heating or cooling stop is controlled by regulating the blasting power and/or the heating effect of hot air.

7. A process as claimed in any one of claims 1 to 6, c h a r a c t e r i z e d in that the cooling is effected by air blasting immediately after said heating or cooling stop.

8. A process as claimed in claim 1 or 2, c h a r a c t e r i z e d in that the glasses broken during heating or cooling stop are collected onto a conveyor set below the lower heating air boxes of the heating furnace, for carrying the glass fragments out of the heat-soak machine.

9. A process as claimed in any one of claims 1 to 8, c h a r a c t e r i z e d in that the process is run as an extension to a tempering process on the on-line principle, such that the glass panels advance through the heat-soak process in substantially the same time as through the tempering machine.

10. A process as claimed in any one of claims 1 to 9, c h a r a c t e r i z e d in that the glass supported by rollers is manoeuvered back and forth or oscillated both during the heat-soak heating sequence and the cooling sequence.

11. A process as claimed in claim 1 substantially as herein described or exemplified.

12. A process as claimed in claim 1 substantially as herein illustrated.

13. A process as claimed in claim 2 substantially as herein described or exemplified.

14. A process as claimed in claim 2 substantially as herein illustrated.